METHOD APPARATUS FOR HORIZONTAL DRILLING AND OIL RECOVERY

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CROSS REFERENCE TO RELATED APPLICATION

This application is based on the provisional application Serial No. 60/233,115, filed on September 18, 2000.

BACKGROUND OF THE INVENTION

Field of the Invention. The invention is generally related to drilling and producing oil from abandoned wells and is specifically directed to horizontal drilling and perforating such wells.

Discussion of the Prior Art. As oil supplies continue to deplete, the ability to recover additional oil from existing and/or abandoned well sites or formations becomes of greater importance. One method for recovering additional oil and gas from a formation is to create holes or perforations which extend horizontally away from the borehole and into the formation.

There are tools in the industry capable forming horizontal bores or holes. These can generally be categorized as (1) hydraulic or (2) flexible shaft tools. As shown in U.S. Patent Nos. 4,317,492 (Summers), 5,439,066 (Gipson) and 5,853,056 (Landers), 5,934,390 (Uthe), hydraulic fluid can be used to create holes or perforations in oil bearing formations. Typically a hose or tube is passed down the existing well bore to a point were the horizontal bore is desired. The hose extends from the surface, where a pump provides pressurized hydraulic fluid, such as water, to erode the rock or sand surrounding the downhole end of the hose. While somewhat effective in forming holes in the strata surrounding the main bore, this method significantly damages the formation, which may hinder additional oil or gas production.

Many tools, such as that shown in U.S. Patent No. 4,226,288 (Collins), as well as those shown in the '056 and '066 patents, provides a flexible shaft which extends from the surface, down the main bore and then turns or bends to extend horizontally into the formation, traveling generally perpendicular to the main bore. While these tools may be suitable for use in very large well bores, they are not suitable for use in wells having smaller bores because the turning radius of the flexible shaft is too great. Additionally,

those tools which turn the entire shaft to provide rotation of a drill bit do not typically travel perpendicular to the well bore. The rotation of the shaft creates a downward spiraling of the drill bit.

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus for forming holes or perforations which extend horizontally away from the borehole and into the formation for recovering additional oil and gas from the formation. The present invention provides a downhole tool capable of drilling horizontally into a formation and further capable of operating in a relatively small well bore, such as those having a diameter of less than six inches. In addition, the tool does not tend to spiral or otherwise deviate from horizontal during drilling operations. The tool of the present invention includes a drill capable of drilling or tunneling through the formation, a magazine or carrier which contains a plurality of hollow joints or segments, a hydraulic pump and a mechanism for assembling and disassembling the segments. Once in place, the assembly mechanism removably attaches a segment from the magazine to the drill.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an illustration of the vertical bore hole, a horizontal bore hole and the assembly of the subject invention.

Fig. 2 is similar to Fig. 1 and shows an alternative embodiment.

Fig. 3 is an illustration of a drill bit used in accordance with the subject invention.

Fig. 4 shows an alternative embodiment for feeding the segments of the system in accordance with the subject invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figures 1 and 2, the present invention provides a downhole tool capable of drilling horizontally into a formation and further capable of operating in a relatively small well bore, such as those having a diameter of less than six inches. The well bore 10 is perforated at the opening 12 for accommodating a horizontal drill bit 14. The drill bit is mounted on the front end of a magazine segment 16. The well bore 10 serves as a storage cell for a plurality of segments 16, forming a magazine 18. As the bit 14 moves horizontally into the strata, segment 16A will advance out of the wellbore

10. At this point the next in line segment 16B will drop into the loading cell 20 and couple to the next ahead segment 16A, permitting the bit 14 to progress further in a horizontal direction. In addition, the tool does not tend to spiral or otherwise deviate from horizontal during drilling operations. As the drill advances into the formation, the assembly mechanism affixes additional segments, which are fed from the magazine. An alternative embodiment is shown in Fig. 2 and operates in the same manner as that shown in Fig. 1.

Specifically, the tool of the present invention includes a drill capable of drilling or tunneling through the formation, a magazine or carrier which contains a plurality of hollow joints or segments, a hydraulic pump and a mechanism for assembling and disassembling the segments. Initially, the tool is lowered into the bore, down to the desired level using known wireline techniques. Once at its destination, the tool may be removably affixed in the bore using any suitable method or mechanism to prevent movement of the tool during operation. Once in place, the assembly mechanism removably attaches a segment from the magazine to the drill. Hydraulic fluid from the pump may then be passed through the hollow segment to the drill to power the bit. The drill the travels out of the tool through an opening or aperture therein and into the formation. The pump of the present invention is preferably located in the tool itself, rather than at the surface. As the drill advances into the formation, the assembly mechanism affixes additional segments, which are fed from the magazine, onto the previously attached or assembled segment. Once the horizontal bore is formed, the drill may be drawn back into the tool. After completing a horizontal bore, the tool may be raised or lowered for further drilling or may simply be rotated to allow an additional horizontal bore to be formed at the same depth.

Although any suitable drill may be used, as shown in Figure 3, the drill typically incorporates a suitable bit 22 and a plurality of drive mechanisms such as the drive wheels or axles 24 disposed on the exterior of the drill to aid in driving or pushing the bit forward into the formation and to provide stability for the bit during operation. Hydraulic fluid from a pump turns the bit in the manner well known to those who are skilled in the art and provides power to the drive mechanism. The drive mechanism may

include wheels, tracks or any other suitable device. Preferably, a plurality of tracks are affixed in a spaced manner about the outside of the bit.

The segments preferably have a hexagonal or octagonal shape to add rigidity and prevent bending during drilling. Each segment has a first, leading end and a second, trailing end. The leading end of each segment corresponds to the trailing end of the segment before it. In this way, the segments may be removably joined by the assembly mechanism and passed into the newly formed horizontal bore. For example, corresponding first and second ends may be threaded internally and externally, respectively. Corresponding ends may have any suitable interlocking arrangement. The segments have a diameter smaller than that of the hole or bore formed by the drill bit. Preferably, each segment is approximately three inches in length and may be formed from any suitable material, but preferably a metal such as steel. It may be desirable, in certain instances, to include spacers or support devices at spaced intervals along the assembled segments. Such spacers provide support for the segments and prevent bending of the assembled segments, which may occur due to the smaller diameter of the segments relative to the horizontal bore. Where spacers are used, they are typically slotted to allow fluid and cuttings to pass out of the horizontal bore. The magazine or carrier may be sized contain any number of segments, preferably, however, the carrier accommodates enough segments to allow the drill to travel approximately forty feet from the main bore.

In a another embodiment, and as shown in Figure 4, the present invention is a downhole horizontal drilling tool which includes a drill, a linked chain drive system and a hydraulic pump. The drill preferably has a plurality of drive mechanisms 24 positioned thereon, as previously described. Hydraulic fluid from the pump drives the drill bit and drive mechanism.

The linked chain drive system includes at least a pair of pulleys 32, 34, one of which may be moved axially within the tool, a linked chain of segments 36, and a drive motor 38. Preferably, the linked chain is hollow to allow fluid to pass therethrough. The last segment in the linked chain is attached to the drill 14. As the drill travels into the formation, the linked chain is pulled into the formation as well. As the linked chain travels into the formation, an upper, axially moveable pulley 32 travels axially

downward, thereby allowing the chain to travel out into the formation while keeping tension in the chain and controlling the rate at which it travels. A lower, fixed pulley 34 allows the chain to turn out of the tool and into the formation. Additional pulleys may be used to further control the movement of the linked chain. The motor 38 controls the movement of the upper pulley and may rotate drill stem 40 inside the linked chain. Alternatively, a pump may supply a hydraulic fluid through the chain to turn the drill bit and drive the drive mechanisms in the manner well known. Once the horizontal bore is formed, the drill and linked chain is drawn back into the tool.

While certain embodiments and features have been disclosed in detail herein, it should be understood the invention includes all enhancements and modifications within the scope and spirit of the following claims.